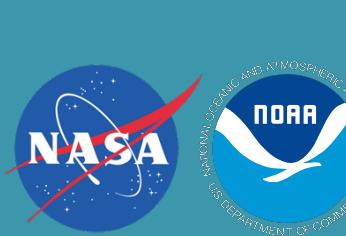


Illustration courtesy of F. Chavez/K. Lance
(Monterey Bay Research Institute/MBARI)

Illustration by Kelly Lance © MBARI 2013



NATIONAL MARINE SANCTUARIES

MBON

Marine Biodiversity
Observation Network

...from microbes to whales

Why measure biodiversity?



Biodiversity benefits:
ecosystem function & resilience,
chemical cycles,
human health (food, materials, chemicals,
recreation)

Life in the Sea

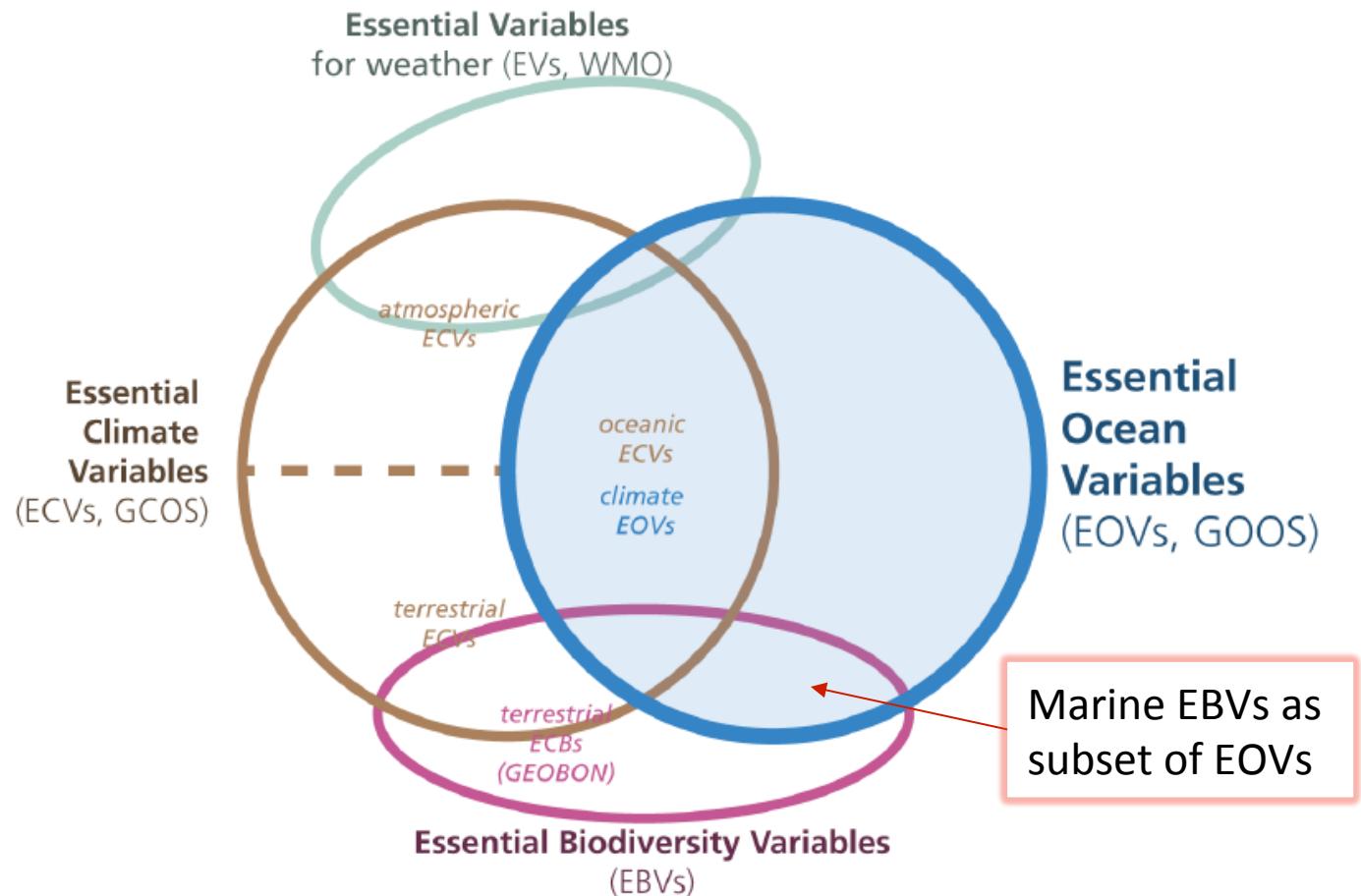


Biodiversity: the variety of life and habitats

- number of species,
- abundance and biomass,
- interactions (organisms & environment),
- variability of habitat

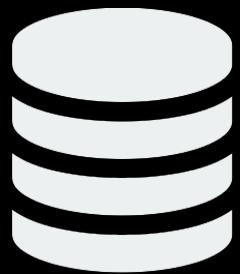
*These 'Essential Biodiversity Variables'
are really basic, but are very difficult to make*

Essential Variables: EOVS and EBVs

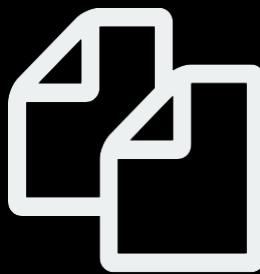


- GOOS: GOOS panels (EOV)
 - Group on Earth Observations (GEO): GEOBON – MBON
 - National / academic programs
- } Need to be linked, and enabled to measure life

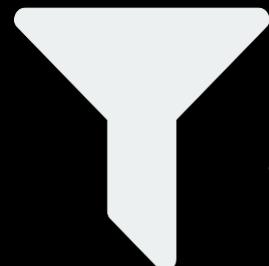
A collaborative **NETWORK** that links



Databases



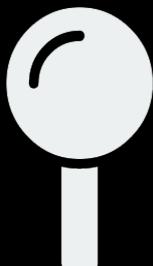
Datasets



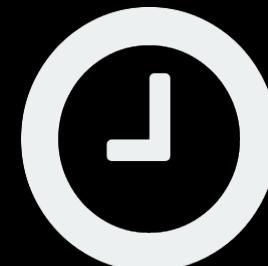
Filters:



Taxa



Space



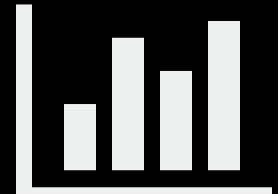
Time



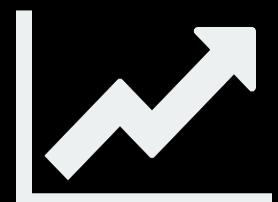
To produce:



Maps



Abundance



Trends

Sanctuaries MBON
demonstration priority:

→ US National Marine Sanctuary
Condition Reports

National Marine Sanctuaries



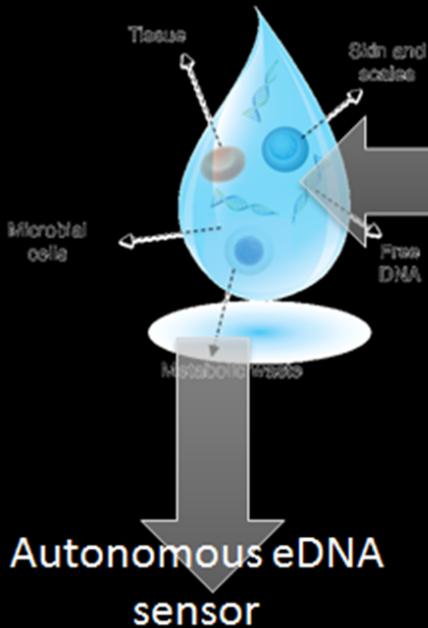
MONTEREY BAY NATIONAL MARINE SANCTUARY



Monterey Bay National Marine Sanctuary
Main Office
99 Pacific Street, Bldg 455A
Monterey, CA 93940
(831) 647-4241
<http://montereybay.noaa.gov>

Environmental Data Integration

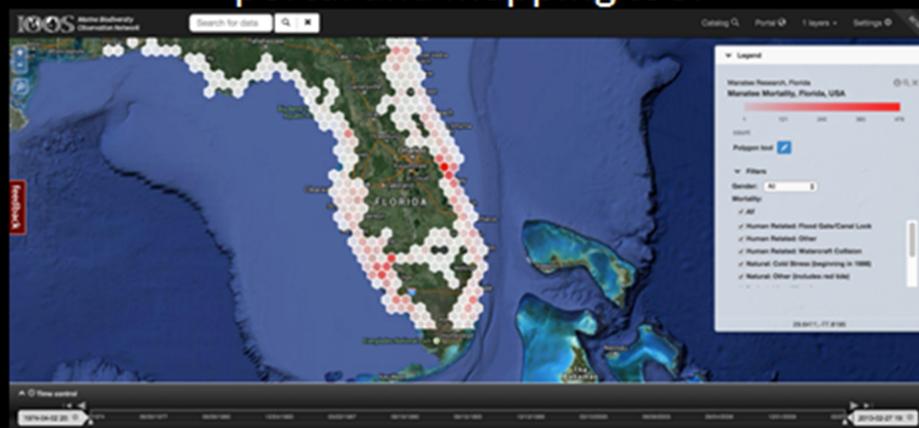
eDNA testing



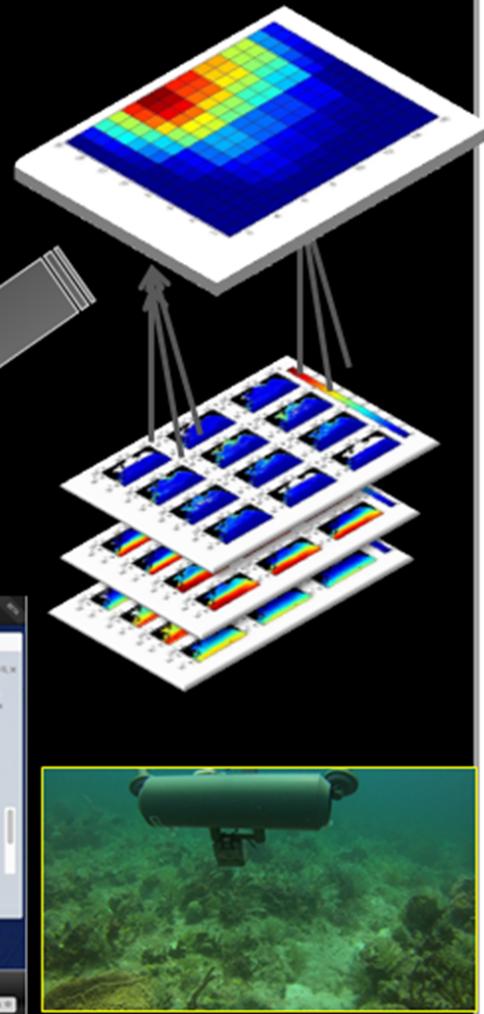
Case Studies

- Integration of 20y+ environmental and biological datasets
- In situ data collection
- E&O
- Socio-economics
- Ecosystem Valuation

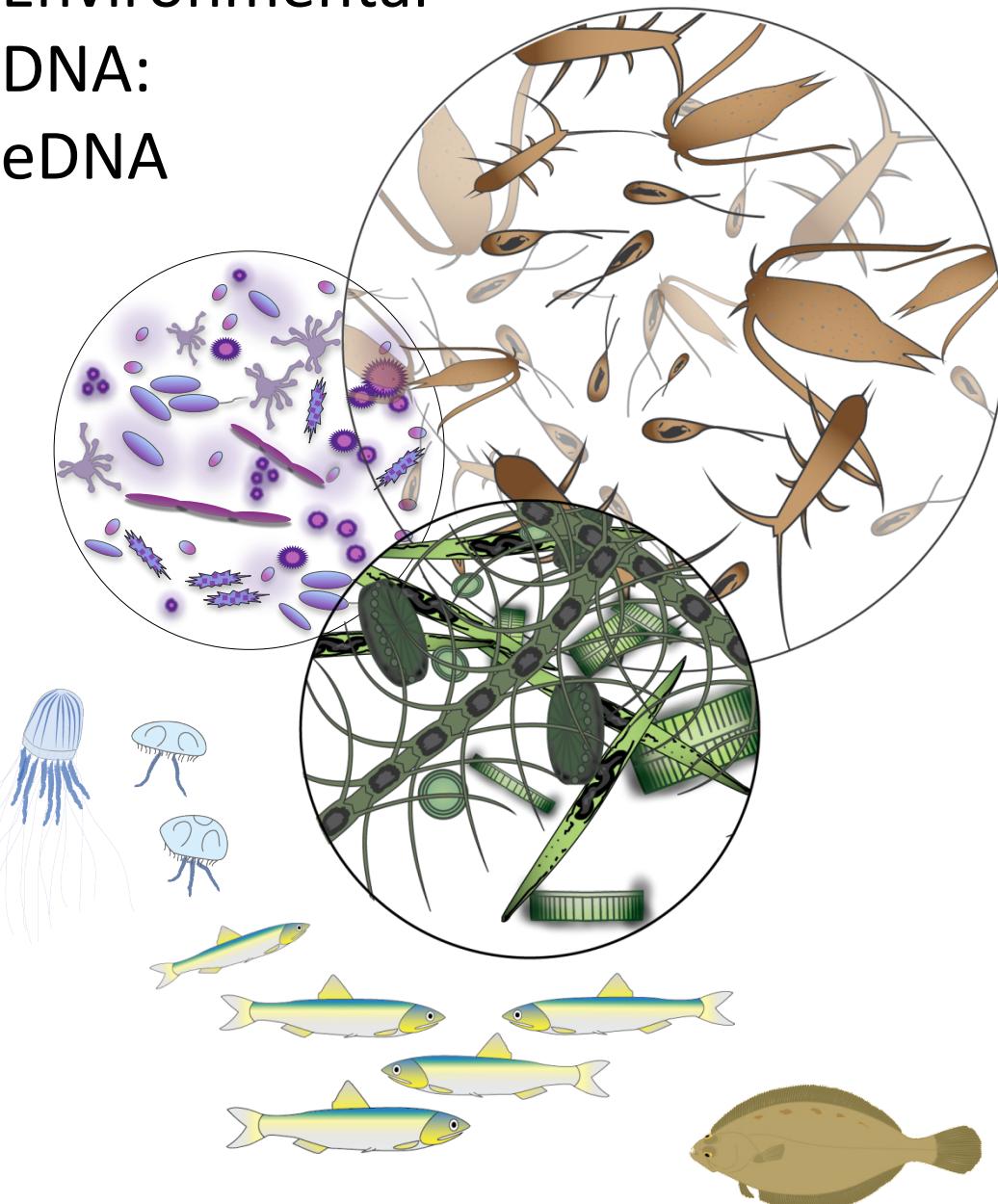
MBON data portal and mapping tool



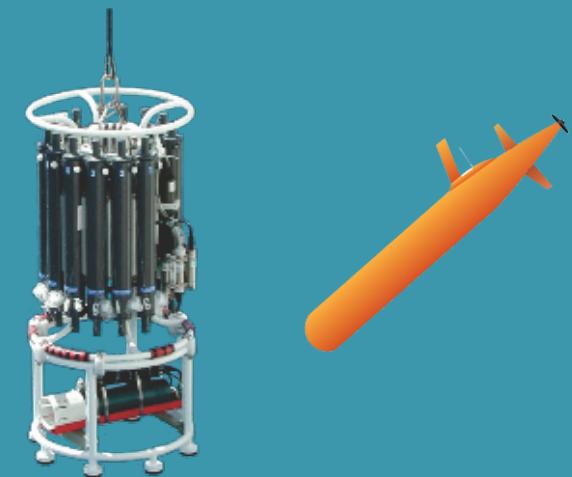
Ecological Marine Units Satellite Seascapes



Environmental DNA: eDNA



eDNA allows detection
of diverse groups using
many platforms



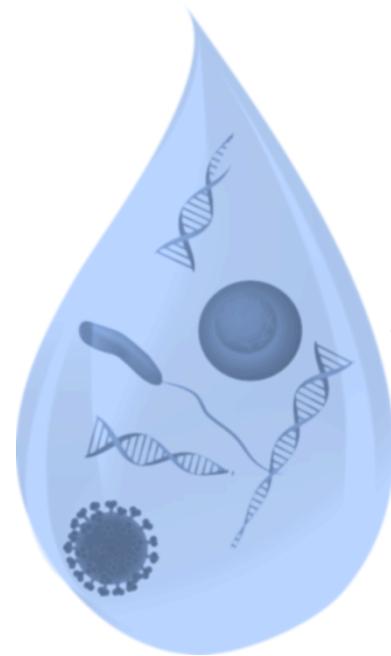
Milestone: MBON Standard Protocol

Filter 1L of
Seawater (x3)

Extract
DNA

Amplify &
Sequence

Identify Target
Organisms



0.2 µm PVDF

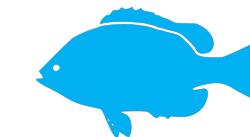
Qiagen
DNeasy

Target
Gene Markers

NCBI GenBank, etc.



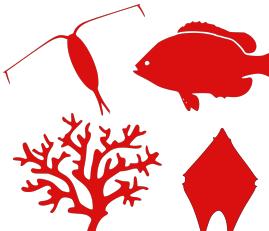
12S rDNA



Vertebrates



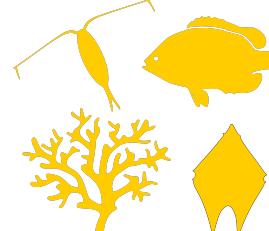
COI



Invertebrates,
some vertebrates,
& phytoplankton



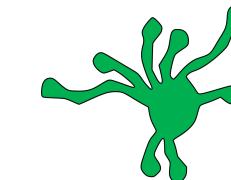
18S rDNA



Phytoplankton &
invertebrates,
some vertebrates



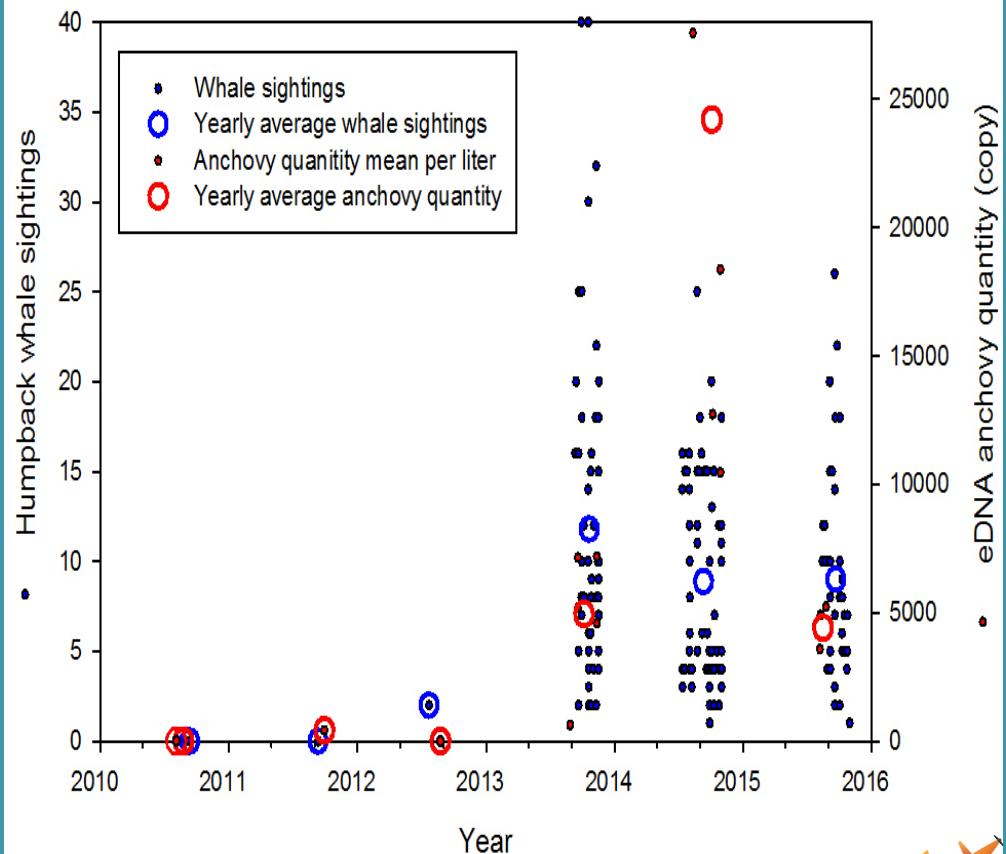
16S rDNA



Microbes
(Bacteria & Archaea)

eDNA detected increased anchovy abundance

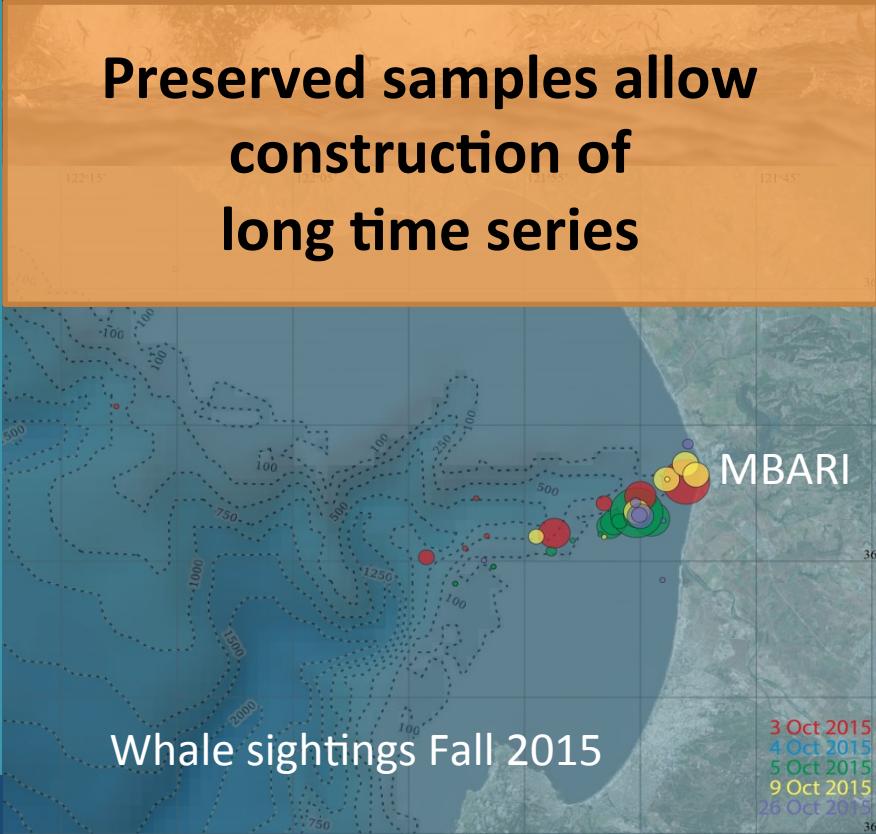
Monterey Bay, CA, station C1



In field trials 3G ESP successfully picked up anchovy eDNA



Preserved samples allow construction of long time series

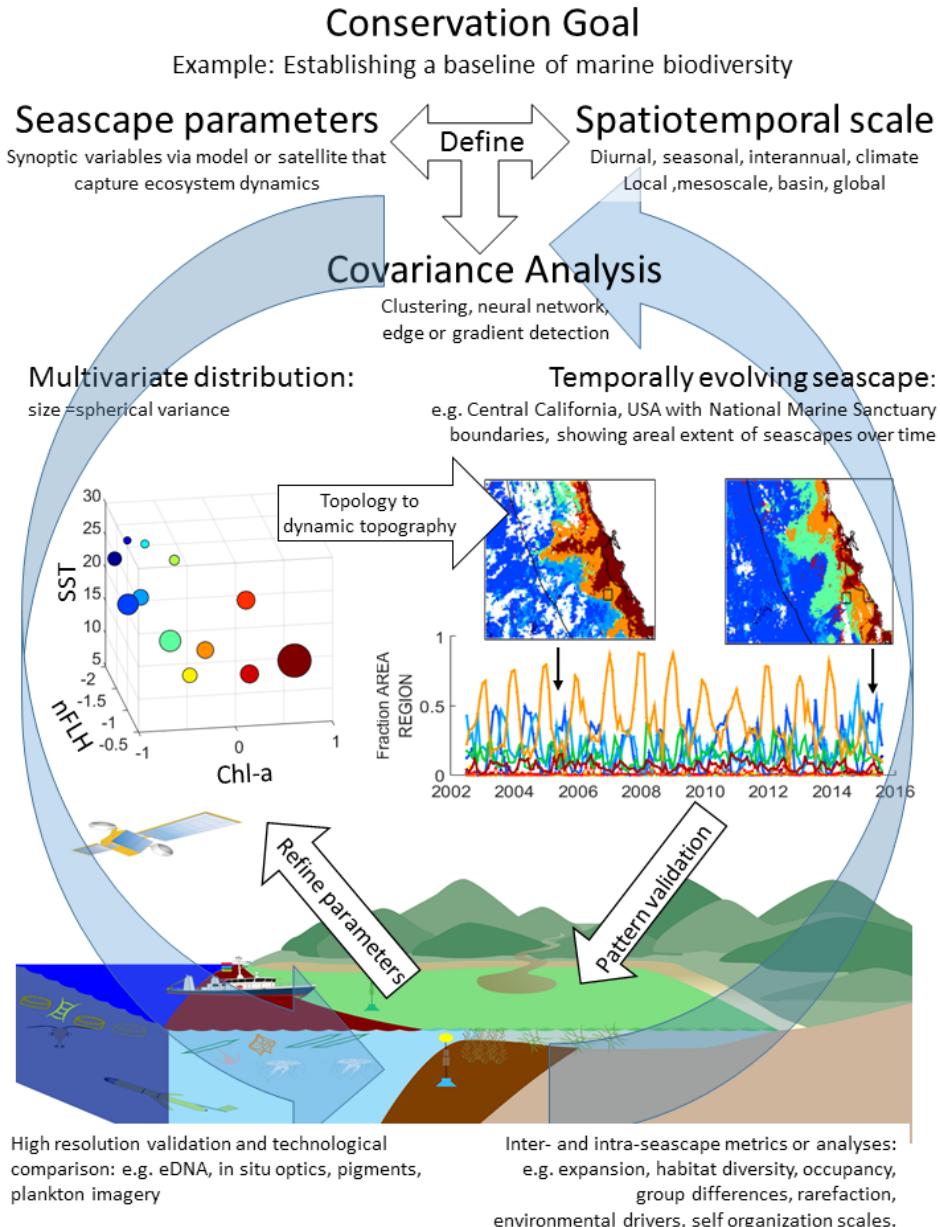


eDNA Recovers a Wealth of Biodiversity from the Florida Keys NMS



MBON and seascapes

- Dynamic biogeographic framework
- Ecosystem comparison
- Indicators and metrics
- Cruise planning, feature tracking
- Seasonal and Interannual dynamics



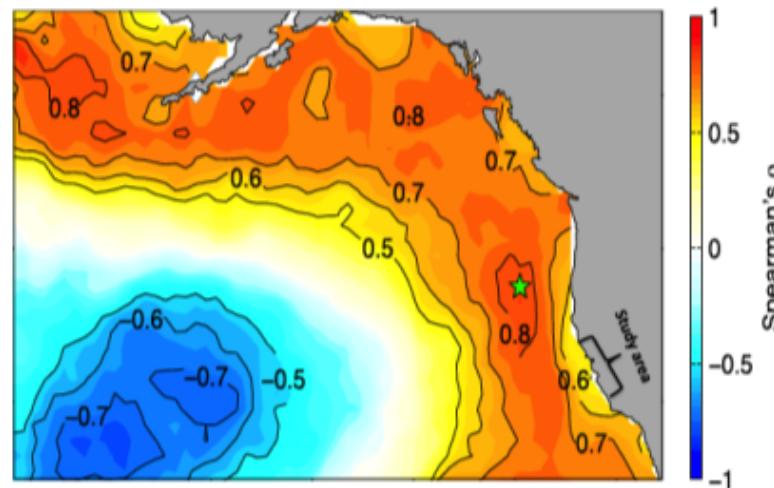
Central California pelagic forage fish and Eastern Pacific climate

Forage fish: food for larger predators (fish, seabirds, marine mammals)

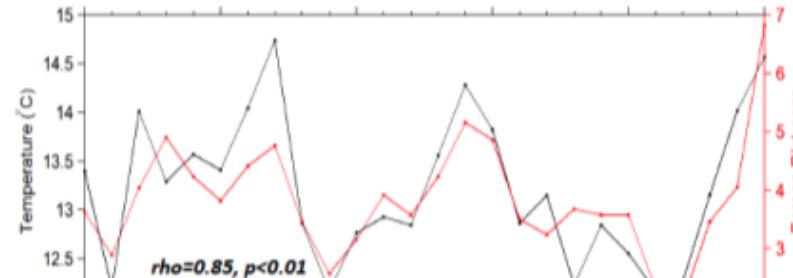
May-June SST & Forage Richness

Figure 7

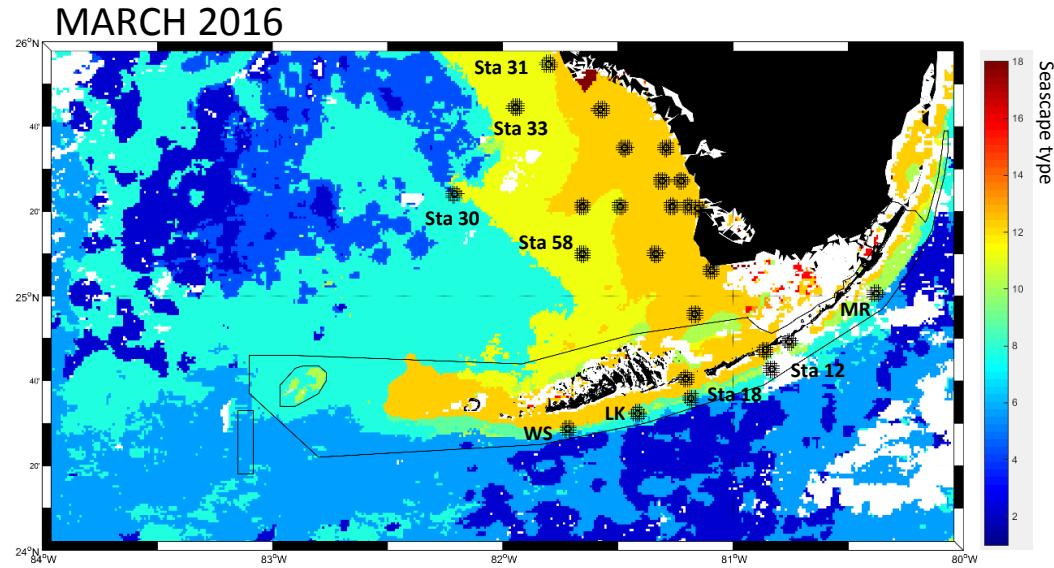
High SST = High Forage Richness



High PDO = High Forage Richness

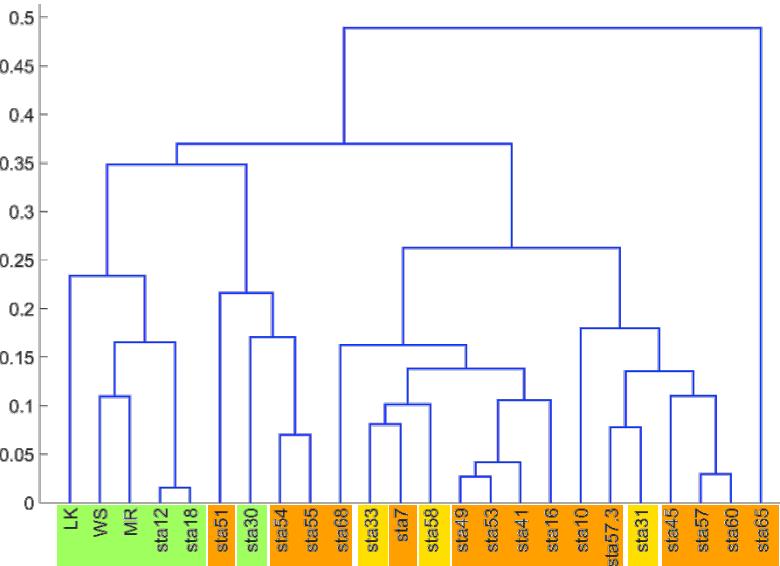


Seascape validation in south Florida waters

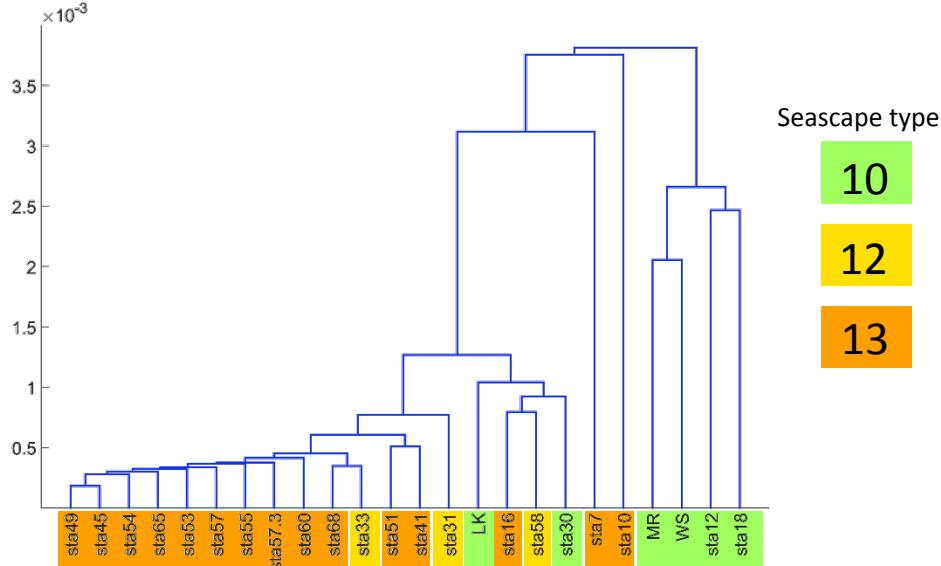


Seascape validation:
Seascapes show
distinct
phytoplankton
communities

Phytoplankton pigments (HPLC)



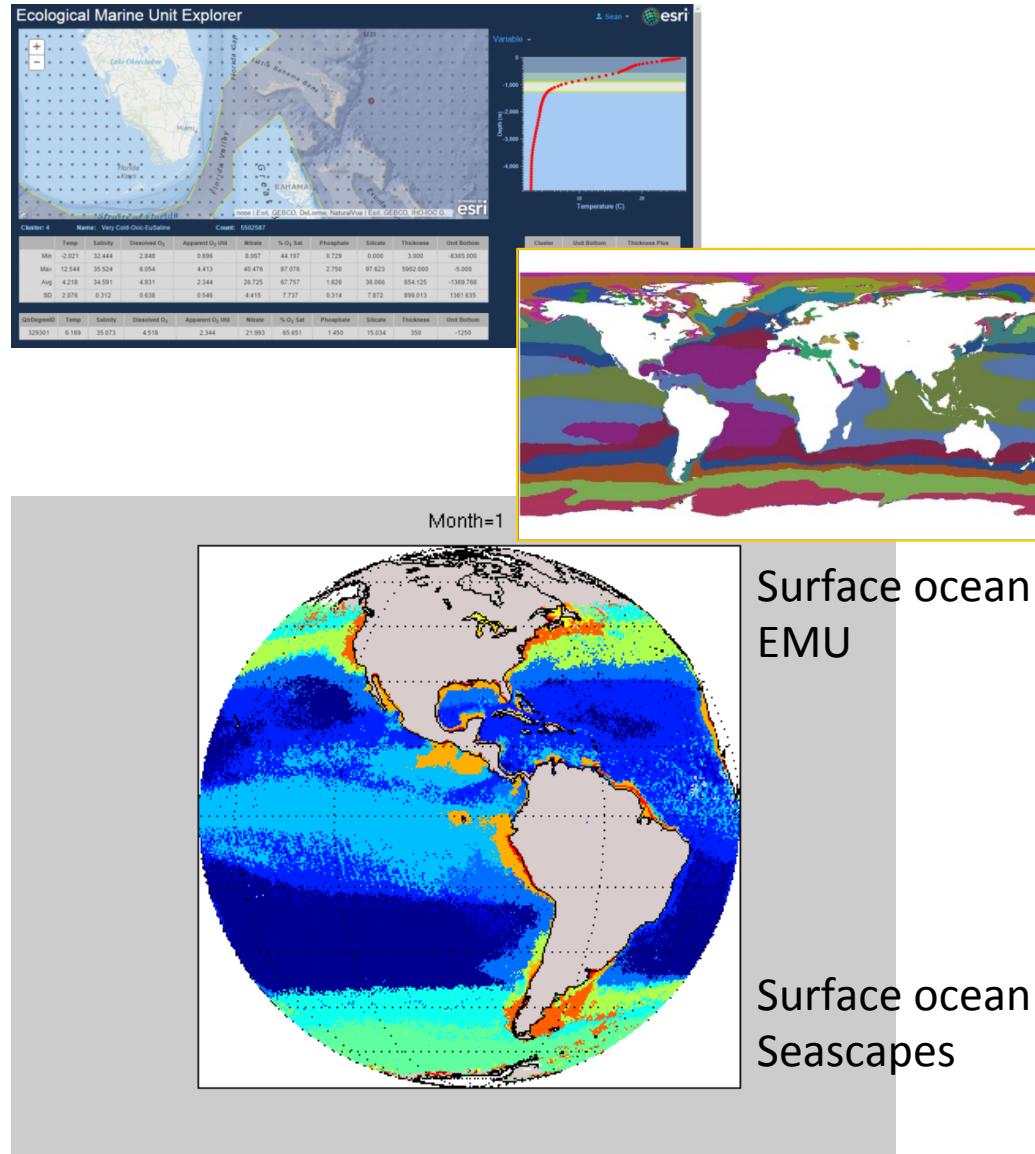
Phytoplankton absorption spectra (a_{phy})



Regional to Global Seascapes

In progress/Next steps:

- Refine science questions
- Automate data flow between NASA, USF, WHOI, IOOS DMAC / Axiom
- COVERAGE: CEOS Ocean Variables Enabling Research and Applications for GEO
- Algorithms: HAB, acidification
- GEOBON and broader links:
 - Link Seascapes and Ecological Marine Units/EMU (USGS/esri)
 - Other partners/internationally

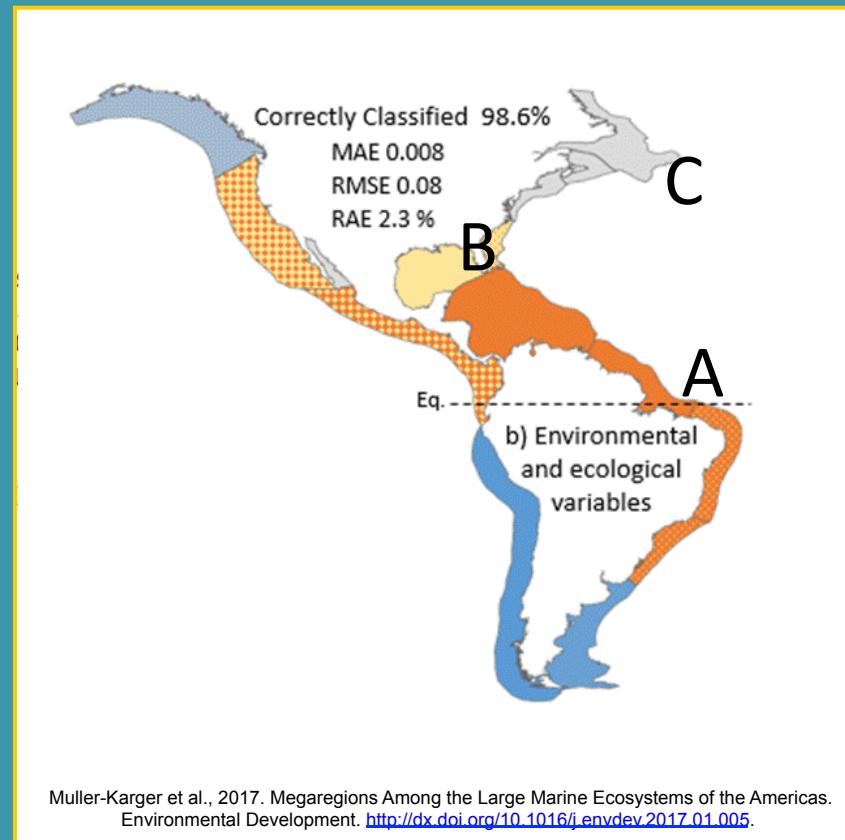


Example: diversity of fisheries and satellite seascapes in Large Marine Ecosystems (LME) of the Americas

Results:

Three megaregions

Between 1982 and 2010,
seven LMEs diversified their
fisheries



Communications & Outreach

CJ Reynolds, Jennifer Brown,
Chris Simoniello, Mitch Roffer

- ## Engage users and support Products
- Quarterly Updates,
 - Short videos,
 - Pod casts,
 - Sanctuaries MBON website,
 - User oriented webinars and tutorials



CENTER FOR
OCEAN
SOLUTIONS

eDNA Video



Coming soon: Sanctuaries.marinebon.org

The image shows a conceptual design for the Sanctuaries MBON website. It features a large, detailed image of a shrimp. Below it are sections for "OUR PROJECTS" (with a map of the US coastline), "WHAT'S NEW" (with a thumbnail for "eDNA TEAM DEVELP STANDARDIZED PROCESSES, SAMPLING AND PREPARE FOR PROCESSING"), and a "MISSION CALENDAR". The overall design is clean and modern with a blue and white color scheme.

Story Map
Secrets in the Sea

The image shows a "Story Map" titled "Secrets in the Sea". It features a background of a deer silhouette and text about researchers using environmental eDNA to characterize marine life. The text reads: "Researchers are using environmental eDNA to characterize marine life in the Gulf of Mexico and the Northeast U.S. continental shelf." A circular logo for "GULF AND NORTHEAST COASTAL CONSERVATION" is visible in the bottom right corner.



Societal Relevance



SUSTAINABLE DEVELOPMENT GOAL 14

Conserve and sustainably use the oceans, seas and marine resources for sustainable development

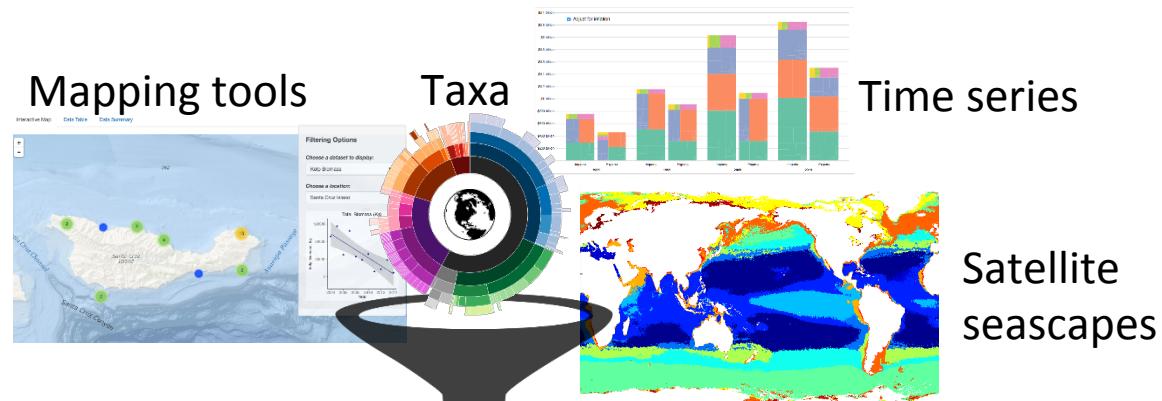


10 targets that require scientific information and capacity building on biodiversity



SDG14

Interactive web-based tool



SUSTAINABLE DEVELOPMENT GOALS

Support

Infographics: Conceptual Models for Status and Trends Products

PELAGIC INDICATORS



KEY CLIMATE & OCEANOGRAPHIC DRIVERS

- Q1, Q13: Nitrogen: Phosphorus
- Q2: HABs - extent, duration, frequency
- Q3: Basin-scale indicators (MEI, NPGO, CUI)
- Q3: pH
- Q3: Sea surface temperature
- Q3: Dissolved Oxygen



KEY HUMAN ACTIVITIES

- Q2, Q13: Contaminants - levels in water, fish
- Q13: Shipping - levels
- Q13: Marine debris abundance
- Q15: # strandings/entanglements
- Q15: Commercial fishing activity level
- Q15: Recreational/ fishing activity level



Q8: Salmon
Abundance



Q8: Leatherback
Abundance



Q8: Pinniped
Pup production & growth

Q7: Phytoplankton/Chl a
Abundance/biomass

Q10: Phytoplankton
Taxonomic structure

Q10: At-sea seabirds
Species richness

Q8: Local nesting birds
Colony size & productivity

Q7: Key forage fish & invertebrates
Species abundance anomaly

Q8: Baleen whales
Local distribution & abundance

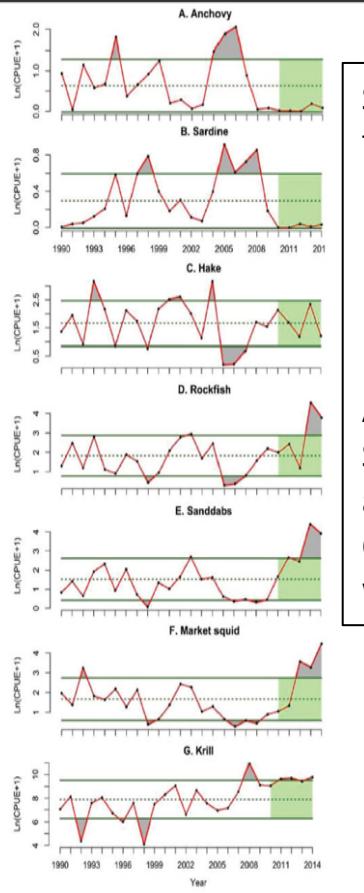
Q8: Gelatinous zooplanton
Relative abundance/biomass

Q10: Key forage
Diversity metrics

Q10: Midwater larval fish
Relative abundance/ biomass by group

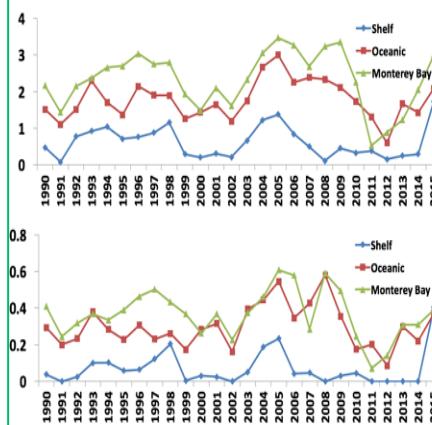
Q9: Non-indigenous species
Density/biomass

3



Seven key pelagic forage groups for MBNMS from NMFS-SWFSC Rockfish Recruitment and Ecosystem Assessment Surveys as reported on CCIEA indicator website

"Forage" Richness and Diversity

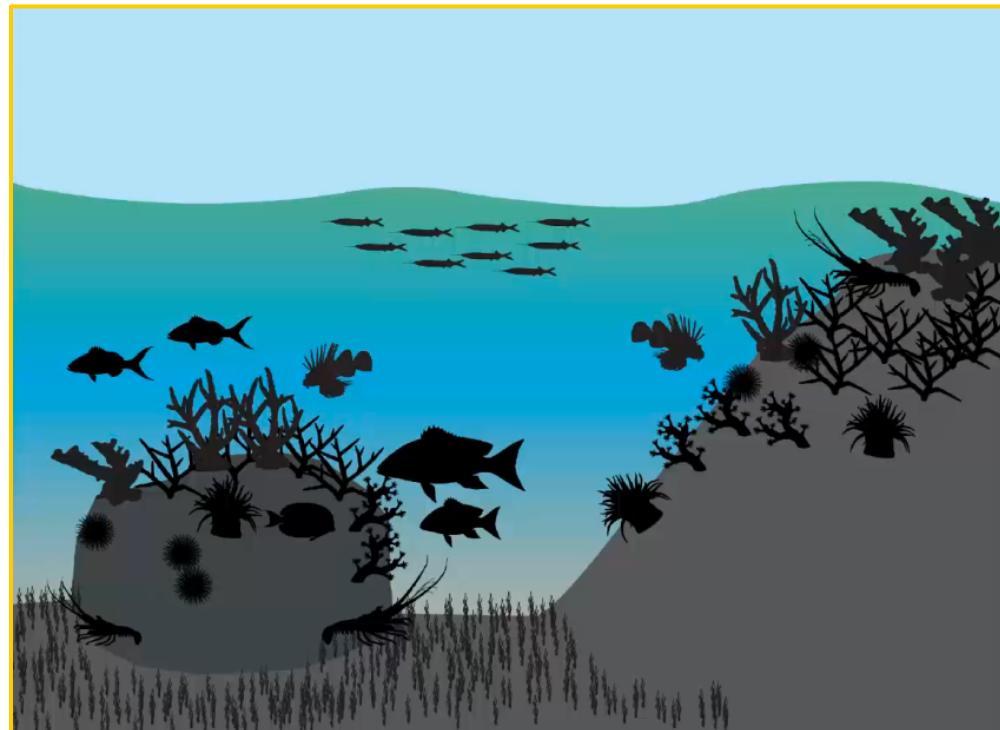


(Santora et al. in review)

Florida Keys Coral Reef Ecosystem

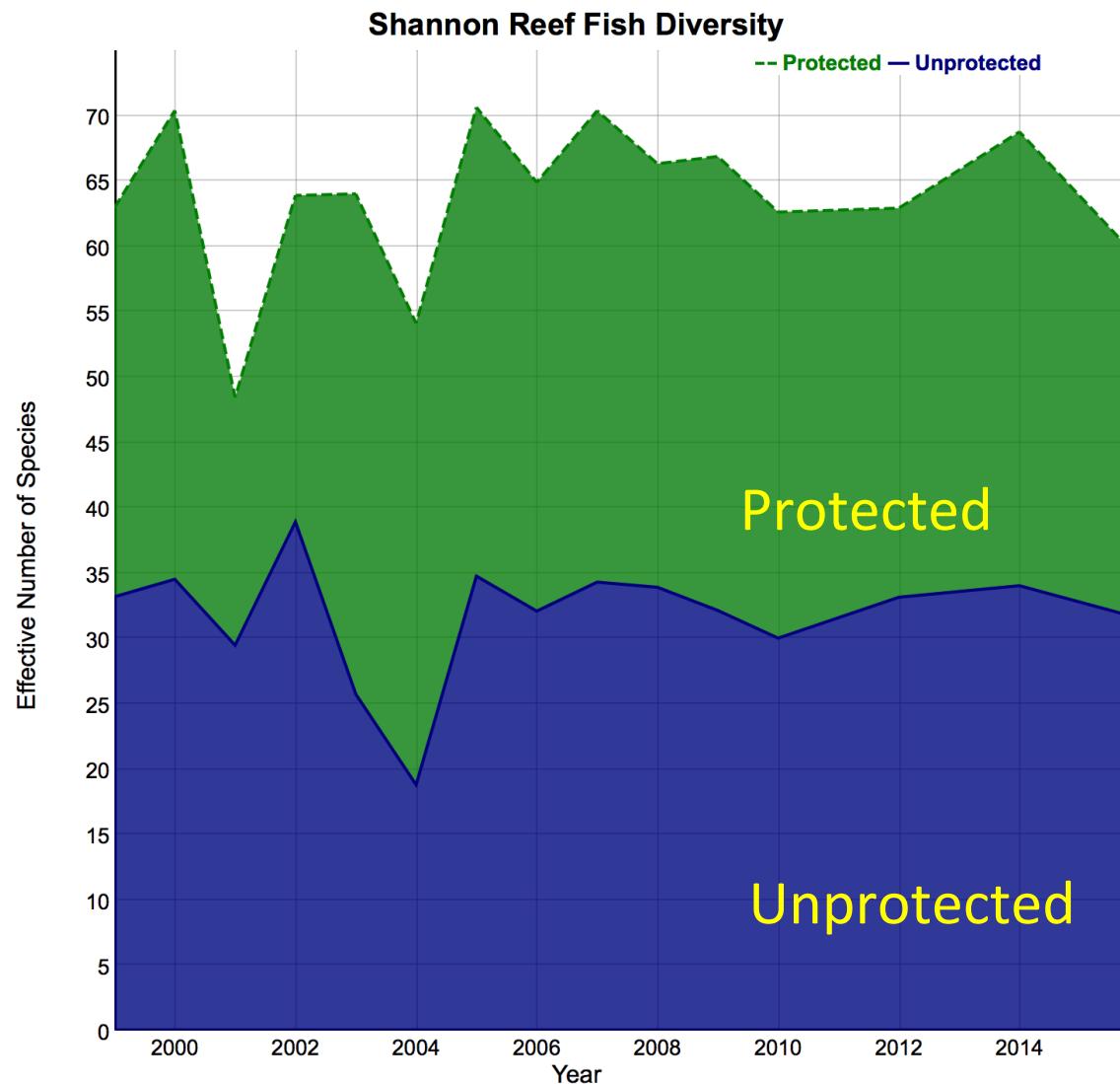
(*Infographic* approach)

1. Reef fish biodiversity
2. Trophic Groups (13)
3. Trophic level (4)
4. Exploited reef fish (9)
5. Stony corals
6. Sea fans
7. Sponges
8. Caribbean spiny lobster
9. Queen conch
10. Sea turtles
11. Black sea urchin



Florida Keys National Marine Sanctuary

Reef Fish Diversity



A Global Collaboration: OBIS + GOOS (IOC) and MBON

GEO BON/MBON – GOOS BioEco – OBIS partnership
Building a globally coherent, consistent and coordinated sustained global ocean observing system to assess the state of the ocean's biological resources and ecosystems

Products,
Indicators,
Assessments

Data &
Products



- Open data sharing
- Data integration
- Data quality control
- Data harmonization
- Tools for data exploration, visualization and analysis

Requirements



Biology & Ecosystems

- Focus on sustained observations
- Bring selected EOVS from pilot to mature
- Link with platforms and observing systems of GOOS and GRAS

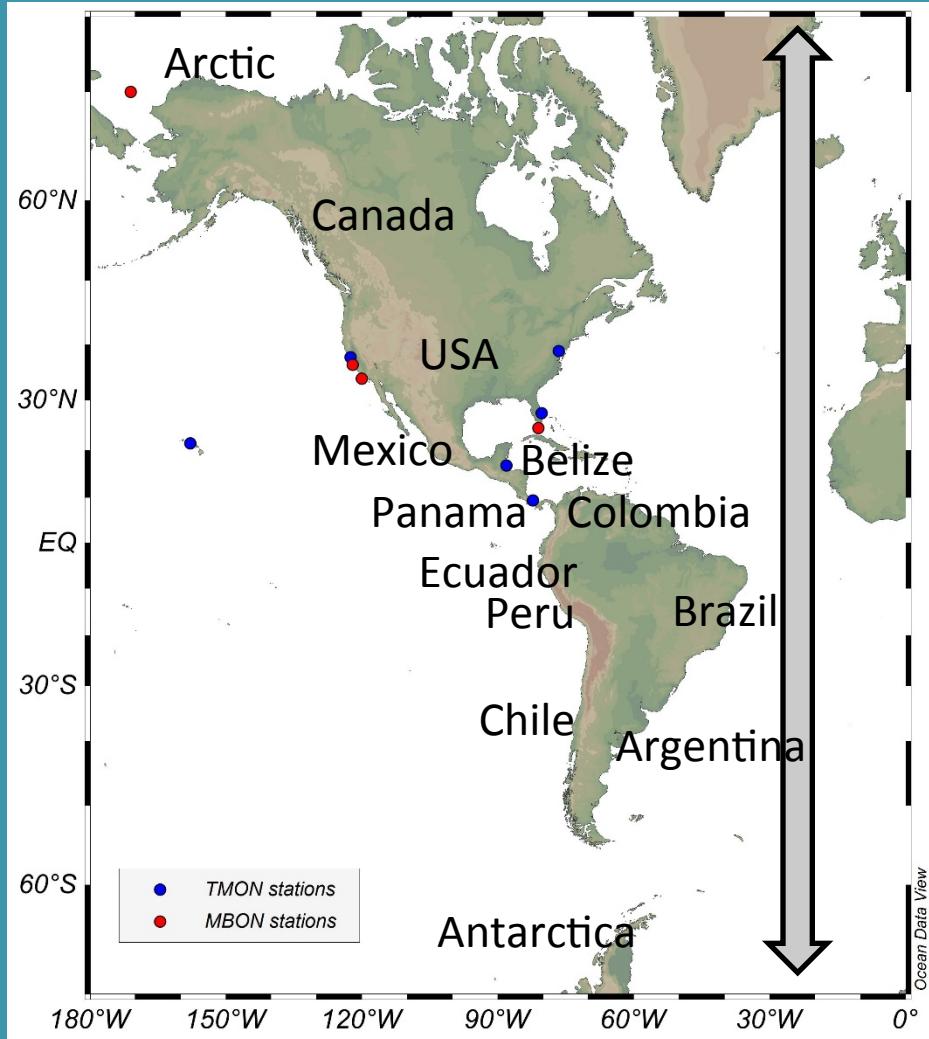
Observations



- R&D focus
- Bring new EOVS from concept to pilot
- Assist with the establishment of national and regional BONS

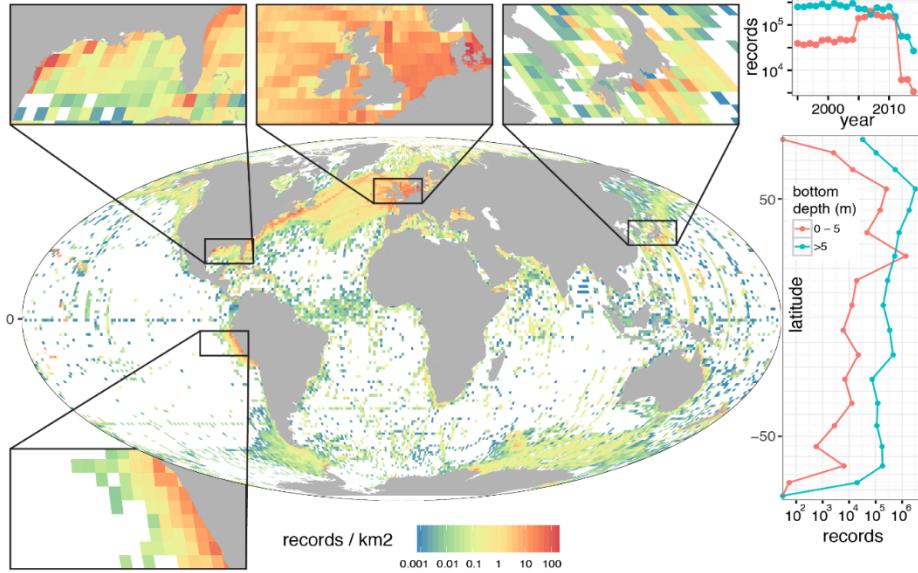
e.g.: <http://iobis.org/2016/12/15/goosgeobonobis/>

Pole-to-Pole MBON of the Americas

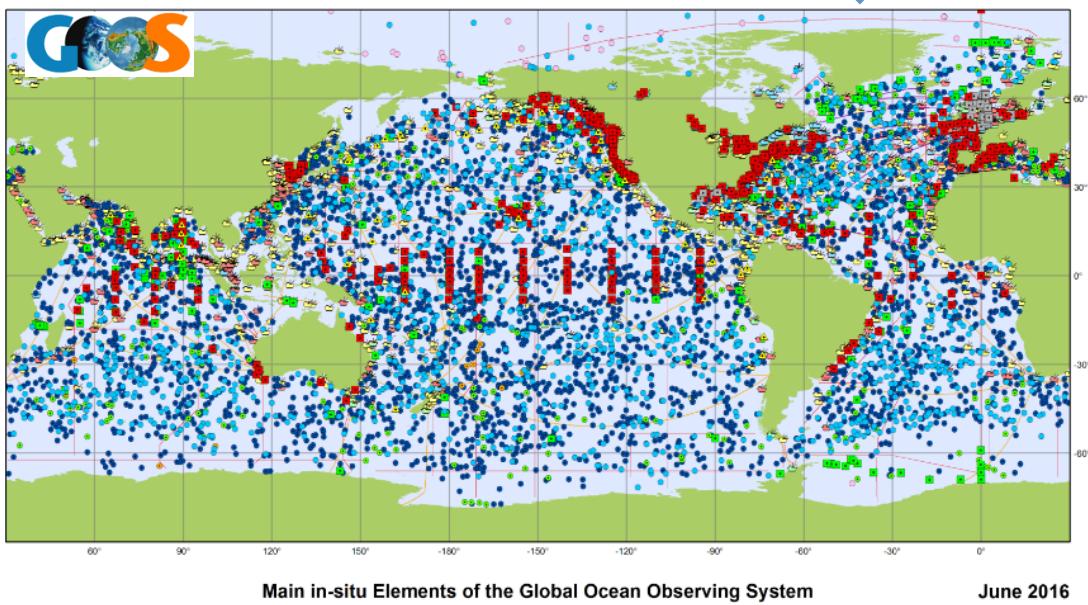


- GEO Plenary, Mexico (2015)
- Convention of Biological Diversity (Montreal, Apr 24, 2016)
- GEO BON Open Science Meeting (Leipzig, Jul 4-6, 2016)
- Pole-to-Pole in the Americas Workshop (Puerto Morelos, Mexico, Sep 26-30, 2016)
- GEO-XIII Plenary (St Petersburg, Russia, Nov 9-10, 2016)
- Animal Telemetry Netw. – Mar,Aug'17
- Blue Planet – May 2017
- AmeriGEOSS –Jul 2017 Costa Rica
- OBIS, GOOS Workshops
- GEO Plenary-Oct 2017
- etc.

Co-chairs linking Africa, Europe, Asia-Pacific



Present to Future



MBON

Marine Biodiversity Observation Network

GOAL:
Increase
observations of
marine life
building on GOOS,
OBIS, and other
networks:

- MarineGEO/Tennenbaum
- UNEP WCMC
- Americas (AmeriGEOSS)
- EuBON
- AsiaPacific
- Coral/GCRMN
- Africa
- CAFF (Arctic)
- National programs
- etc.



GULF OF MEXICO
COASTAL OCEAN
OBSERVING SYSTEM



13 Hands-on STEM Lessons:
Elementary, Middle, High
Standards cross-referenced
Science Festivals (4 annual)
Professional development
of educators
Outreach to minorities



Observing Life in the Sea



Santuary MBON Co-Investigators:

- Frank Muller-Karger (carib@usf.edu)
- Francisco Chavez (chfr@mbari.org)

The US Sanctuaries MBON Team

GEO BON MBON co-chairs:

- Frank Muller-Karger (carib@usf.edu)
- Isabel Sousa Pinto (ispinto@ciimar.up.pt)
- Mark Costello (m.costello@auckland.ac.nz)

MBON
Marine Biodiversity
Observation Network